US009482439B2

(12) **United States Patent**
Akhtar

(10) **Patent No.: US 9,482,439 B2**
(45) **Date of Patent: Nov. 1, 2016**

(54) **AIR HANDLING DEVICE**

(76) Inventor: **Salman Akhtar**, Kitchener (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 977 days.

(21) Appl. No.: **13/269,665**

(22) Filed: **Oct. 10, 2011**

(65) **Prior Publication Data**

US 2013/0090052 A1 Apr. 11, 2013

(51) **Int. Cl.**

F24F 7/06	(2006.01)
F24F 7/007	(2006.01)
F24F 3/044	(2006.01)
F24F 13/20	(2006.01)

(52) **U.S. Cl.**

CPC ***F24F 3/044*** (2013.01); ***F24F 13/20*** (2013.01); *F24F 2013/205* (2013.01)

(58) **Field of Classification Search**

CPC F24F 13/24; F24F 7/007
USPC 454/186, 234, 906; 181/224, 225
See application file for complete search history.

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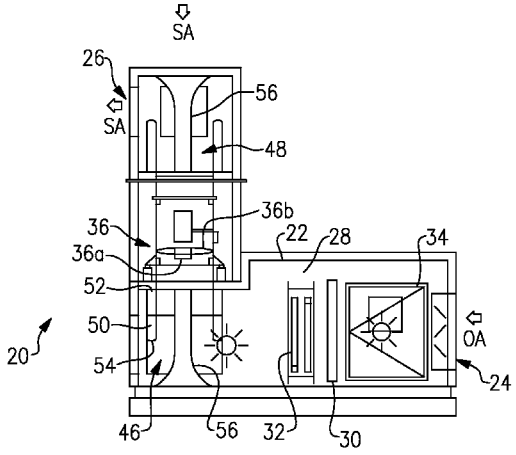
Primary Examiner — Steven B McAllister
Assistant Examiner — Jonathan Cotov
(74) *Attorney, Agent, or Firm* — Carlson, Gaskey & Olds, P.C.

(57) **ABSTRACT**

An air handling device includes a fan that has a fan hub and a set of fan blades that extend from the fan hub. The set of fan blades defines a fan diameter and the fan hub defines a hub diameter. The fan has an inlet side for air intake and an outlet side for air discharge. An annular fan inlet passage is arranged at the inlet side of the fan, and an annular fan outlet passage arranged at the outlet side of the fan. The fan inlet passage and the fan outlet passage each define an outer diameter that is substantially equivalent to the fan diameter and an inner diameter that is substantially equivalent to the hub diameter.

15 Claims, 5 Drawing Sheets



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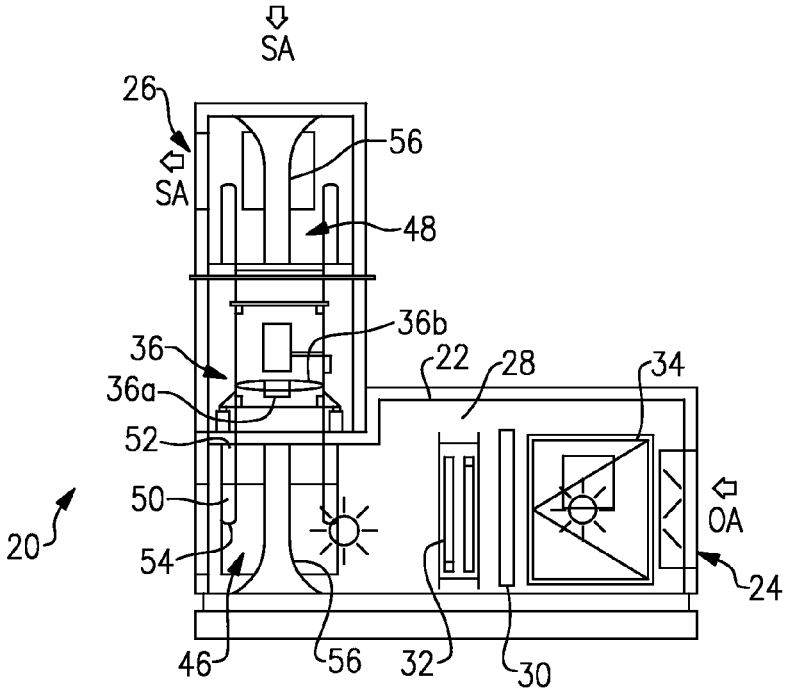
SA
26
SA
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FIG.1

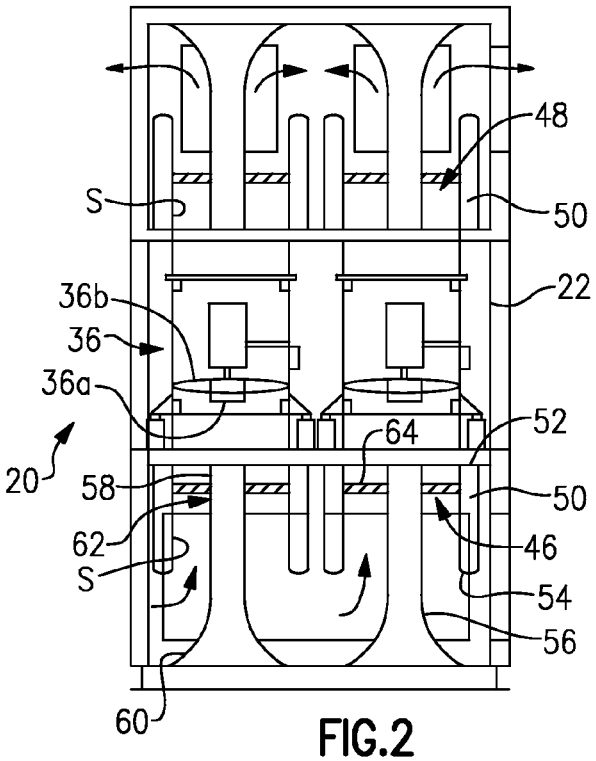
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FIG.2

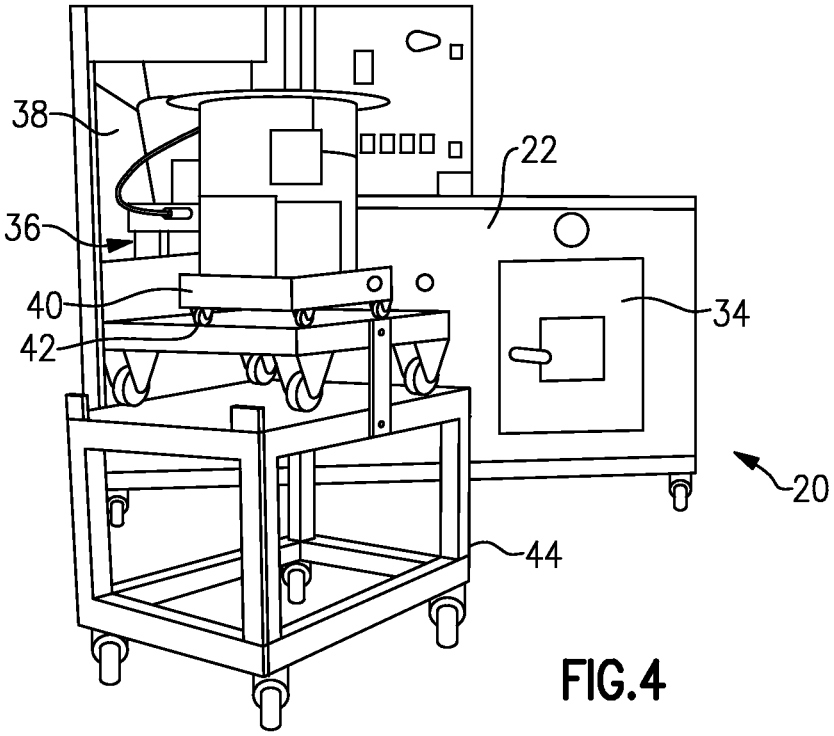


FIG.4

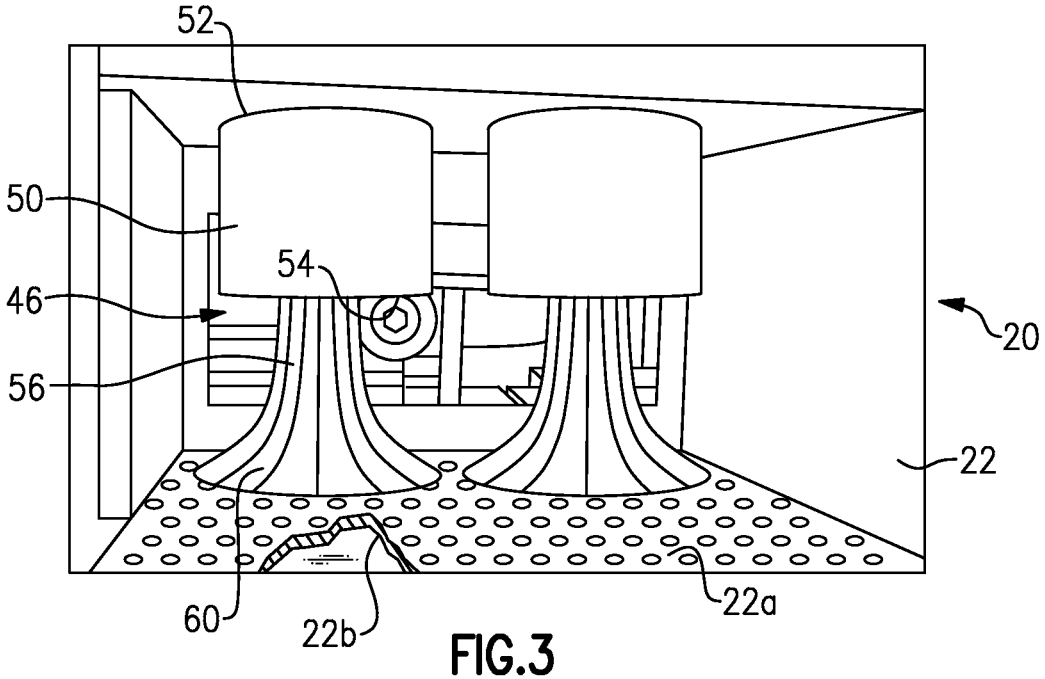


FIG.3

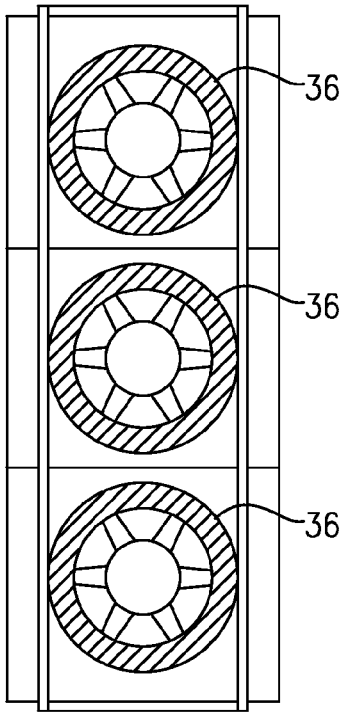


FIG.6

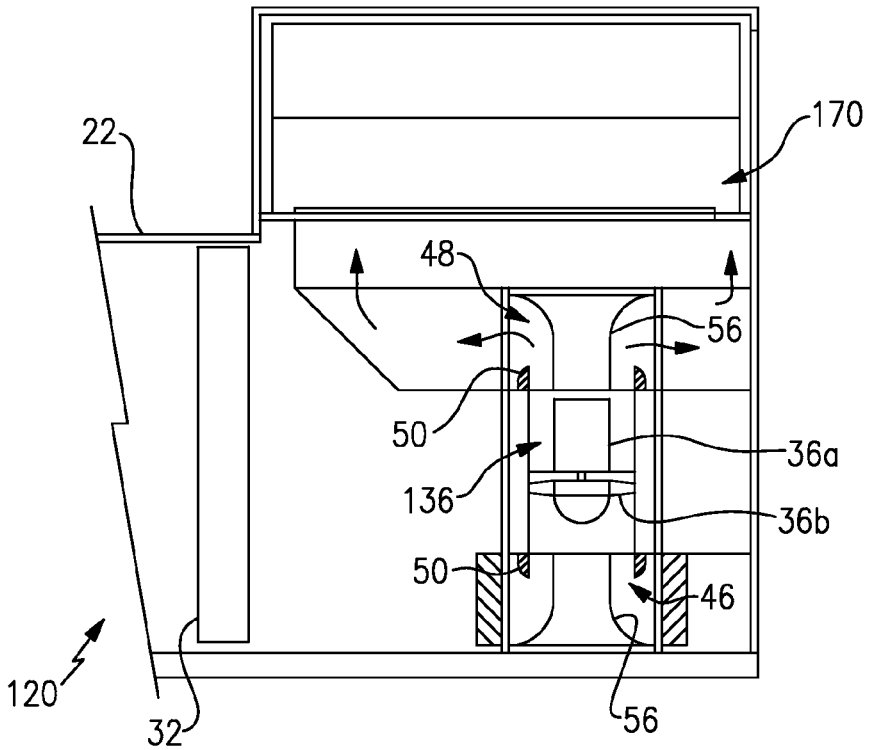


FIG.5

FIG.7

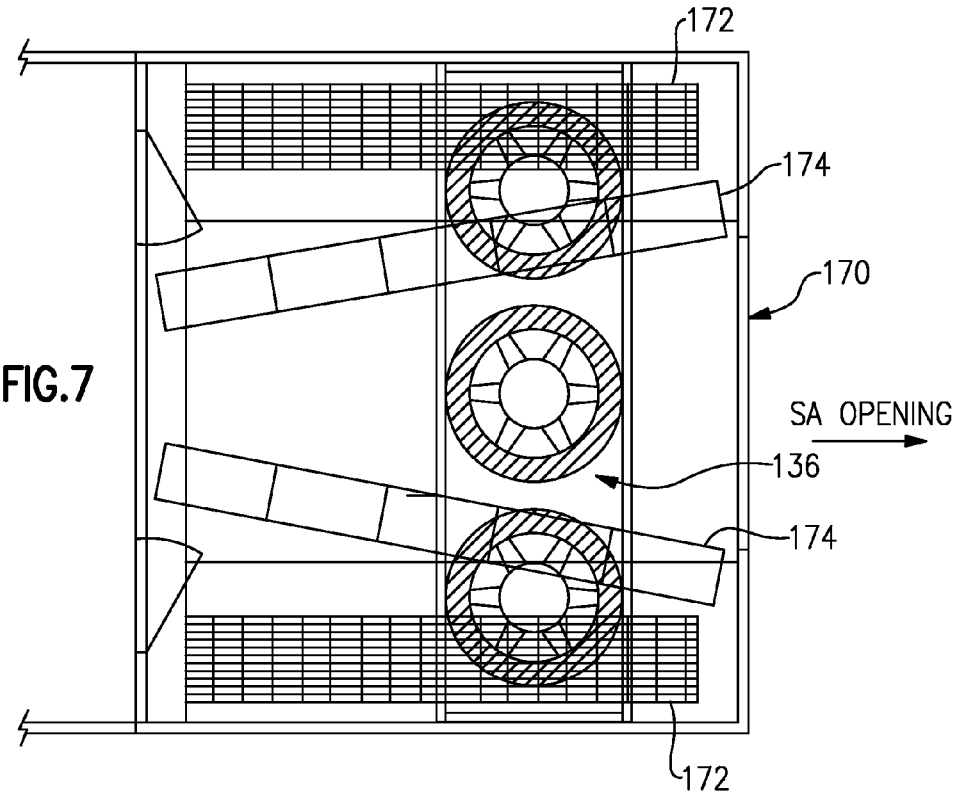
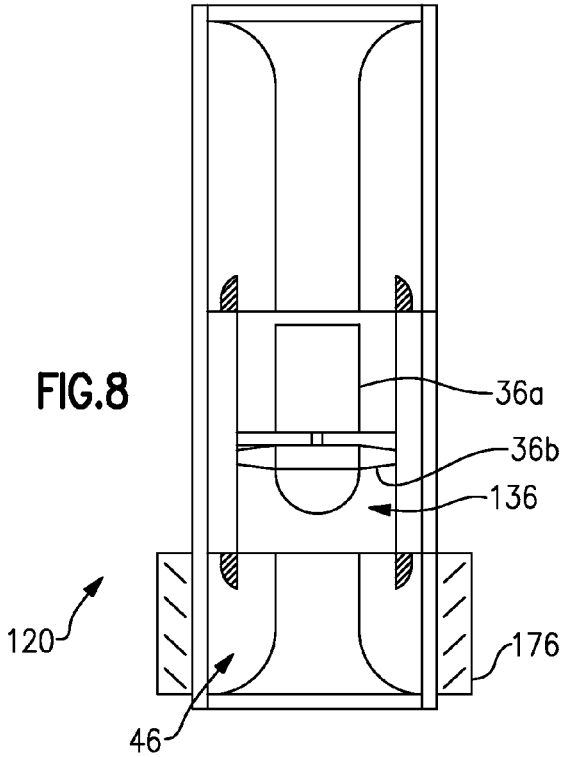


FIG.8



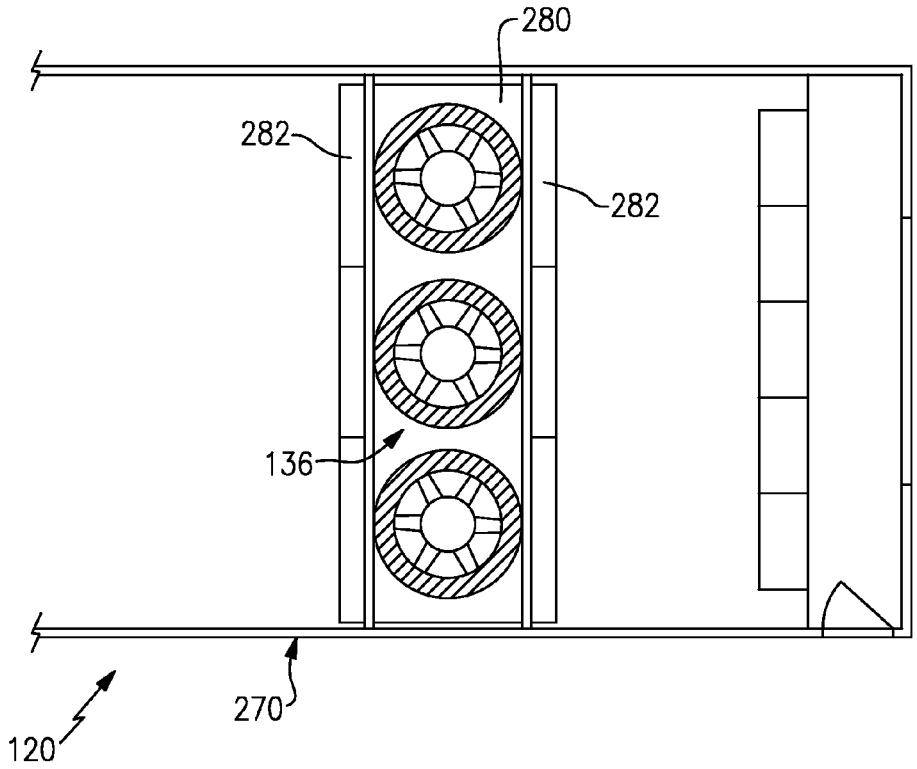


FIG.9

AIR HANDLING DEVICE

BACKGROUND OF THE INVENTION

This disclosure relates to air handling systems for supplying conditioned air to a building or other structure.

Conventional air handling systems are known and used to supply conditioned air to a room, a building or other structure. For instance, air handling systems typically include an air handling unit that is generally enclosed within a housing. The air handling unit may include an inlet for the intake of air and an outlet for the discharge of conditioned air. A fan is arranged between the inlet and the outlet for drawing in air and discharging conditioned air. The air handling unit may also include a heat exchange coil for heating or cooling the air and one or more filters for removing particles or dust from the air.

SUMMARY

Disclosed is an air handling device that includes a fan that has a fan hub and a set of fan blades that extend from the fan hub. The set of fan blades defines a fan diameter and the fan hub defines a hub diameter. The fan has an inlet side for air intake and an outlet side for air discharge. An annular fan inlet passage is arranged at the inlet side of the fan, and an annular fan outlet passage arranged at the outlet side of the fan. The fan inlet passage and the fan outlet passage each define an outer diameter that is substantially equivalent to the fan diameter and an inner diameter that is substantially equivalent to the hub diameter.

BRIEF DESCRIPTION OF THE DRAWINGS

The various features and advantages of the disclosed examples will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

FIGS. **1-3** show different views of an example air handling device.

FIG. **4** shows an example air handling device with one of the fans removed.

FIG. **5** shows another example air handling device.

FIG. **6** shows a bank of fans of the air handling device of FIG. **5**.

FIG. **7** shows a plenum box for use with the air handling device of FIG. **5**.

FIG. **8** shows dampers of the air handling device of FIG. **5**.

FIG. **9** shows another example plenum box for use with the air handling device of FIG. **5**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. **1-4** show different views of an example air handling device **20** for supplying air to the interior of a building, for example. More specifically, FIG. **1** shows a side cross-sectional view of the air handling device **20**, FIG. **2** shows a different side cross-sectional view of the air handling device **20**, FIG. **3** shows a perspective view of a portion of the air handling device **20** and FIG. **4** shows a view of the air handling device **20** with one of the fans removed. As will be described in more detail below, the disclosed air handling device **20** provides the advantage of flexibility in that one or more of the fans can be easily removed for maintenance, replacement or the like. Furthermore, as will also be described, the air handling device **20** includes features for efficient and quiet operation.

In the illustrated example, the air handling device **20** includes a housing **22** that generally defines an inlet **24** for the intake of air and an outlet **26** for the discharge of conditioned air. The housing **22** generally defines an open interior space **28** in which a prefilter **30** and one or more heat exchange coils **32** are located for conditioning air received through the inlet **24**. It is to be understood that the configuration with regard to any filters and heat exchange coils can be modified from the illustrated example to meet the needs of a particular application. The housing **22** also includes an optional access panel **34** for providing access to the prefilter **30** and coils **32** for maintenance, replacement or the like.

A bank of fans **36** is arranged downstream from the prefilter **30** and coils **32**, relative to the inlet **24** and outlet **26**, for moving the air between the inlet **24** and the outlet **26**. In this example, the fans **36** are electric motor-driven axial flow fans that are arranged vertically such that the axis of rotation of each of the fans **36** is vertically oriented. It is to be understood, however, that the fans **36** may alternatively be arranged horizontally or at any angle between horizontal and vertical. In one alternative, the fans **36** are centrifugal fans instead of axial flow fans and may also be arranged horizontally, vertically or at any angle there between.

As illustrated in FIG. **4**, one beneficial feature of the exemplary air handling device **20** is that the air handling device **20** is optionally designed for easy removal of one or more of the fans **36**. In the illustrated example, the housing **22** of the air handling device **20** can include at least one access window **38** (i.e. opening) that allows for easy installation and removal of the fans **36**. The access window **38** includes an opening in the housing **22** and is suitably sized to receive at least one of the fans **36** there through. That is, the opening is at least as large as the individual fans **36**. Optionally, the access portion **38** can include a moveable or removable access door for enclosing the fans **36** within the housing **22** during operation.

In the illustrated example, the bank of fans **36** includes two such fans. It is to be understood that in other examples the bank of fans **36** may include additional fans, depending on the requirements of the system. As shown, the two fans **36** are arranged side-by-side. In other examples that utilize additional fans **36**, the additional fans may also be arranged side-by-side in a row. In a further example, the fans **36** are arranged in an array or matrix that includes a plurality of rows.

As shown most clearly in FIG. **4**, each of the fans **36** has a base **40** that permits easy installation and removal of the fan **36** through the access portion **38**. That is, the base **40** includes sliding surfaces **42** for sliding the fans **36** in and out of the housing **22**. In embodiments, the sliding surfaces **42** of the base **40** of the fans **36** include castors and/or an anti-friction material, such as a polymeric material, that facilitates sliding movement of the fans **36** into or out of the housing **22**.

Optionally, the air handling device **20** may be provided with a transport device **44** that is adapted to receive and securely support at least one of the fans **36** for moving one or more of the fans **36**. In the illustrated example, the transport device **44** is a cart that is of suitable height such that the top of the cart approximately aligns with the bottom of the access portion **38** of the housing **22**. Thus, the height of the cart allows the fans **36** to be removed from the housing **22** through the access portion **38** and onto the cart. Similarly, the height of the cart also allows a fan **36** that is on the cart

to be slid from the cart through the access window **38** and into the housing **22**. Thus, the fans **36** can be readily installed into the housing **22**, removed for maintenance or easily replaced. Once in the housing **22**, the fans **36** can be secured in place using bolts or other fasteners.

As shown in FIGS. **1** and **2**, each of the fans **36** includes a hub **36***a* and a set of fan blades **36***b* that extend from the hub **36***a*. The set of fan blades **36***b* defines a fan diameter and the fan hub **36***a* defines a hub diameter. In the illustration, each fan **36** has an inlet side below the set of fan blades **36***b* for air intake and an outlet side above the set of fan blades **36***b* for air discharge.

Each of the fans **36** further includes a fan inlet **46** and a fan outlet **48** for, respectively, intake of air into the fans **36** and discharge of the air from the fans **36**. As will be described, the inlets **46** and outlets **48** are designed for efficient and quiet movement of the air.

In the illustrated example, each of the fan inlets **46** and fan outlets **48** includes a housing portion **50** defining a cylindrical internal space S having a diameter that is substantially equal to the diameter of the fans **36**. Each of the housing portions **50** extends between a first end **52** near its respective fan **36** and a second end **54** located farther away from the fan **36**. Air guide members **56** extend through the interior of each of the housing portions **50**. As shown, each of the air guide members **56** extends between a first end **58** near its corresponding fan **36** and a second end **60** located farther away from the fan **36**.

Each air guide member **56** includes a substantially cylindrical portion **62** that extends from the first end **58** and in the respective housing portion **50** such that there is an annular passage defined between the inner diameter of the housing portions **50** and an outer diameter of the cylindrical portion **62**. Each cylindrical portion **62** is substantially equal in diameter to the diameter of the hub **36***a*. Thus, the diametrical distance over which each annular passage extends between the respective cylindrical portion **62** and the corresponding housing portion **50** is substantially equal to the span of the blades **36***a* from the hubs **36***b*.

Each annular passage extends over an axial length defined between the first end **52** and the second end **54** of the corresponding housing portion **50**. In one example, the axial distance is greater than the diametrical distance of the annular passage. That is, an aspect ratio of the axial length divided by the diametrical distance is greater than one.

Each of the air guide members **56** extends from the interior of the housing portions **50** beyond the second ends **54** and gradually increases in diameter to the terminal second end **60**. Thus, the shape of the air guide members **56** provides a uniform size annular passage between the air guide member **56** and the housing portions **50** and a non-uniform passage beyond the second ends **54** of the housing portions **50**.

Optionally, the housing **22** may also include one or more perforated surfaces **22***a* (FIG. **3**) located near the fan inlets **46** and/or fan outlets **48**. The perforated surfaces **22***a* are backed by a liner material **22***b* of insulation that is made out of plastic or cloth. The combination of the perforated surface **22***a* and the liner material **22***b* provides the benefit of sound attenuation within the air handling device **20**.

As shown in FIGS. **2** and **3**, the housing portions **50** of the fan inlets **46** and fan outlets **48** are spaced apart from the neighboring housing portion **50**. Thus, each fan **36** includes its own fan inlet **46** and fan outlet **48**. Moreover, the housing portions **50** and the spacing between the housing portions **50** function as baffles within the interior of the housing **22** to mix air near the fan inlets **46** and, at the discharge end, mix air discharged through the fan outlets **48**.

Optionally, as shown in FIG. **2**, at least one of the annular passages of the air handling device **20** includes at least one vane **64**. Each such vane **64** extends from a respective air guide member **56** to the corresponding housing portion **50**. In a further example, each annular passage includes a plurality of vanes **64** that are circumferentially spaced around a respective air guide member **56**.

In operation, the fan inlets **46** and the fan outlets **48** facilitate efficient and quiet operation of the air handling device **20**. At the fan inlets **46**, the housing portions **50** and air guide members **56** prepare the air to enter the fans **36**. In one example, when the air enters through the inlet **24** of the housing **22**, the air is moving relatively slowly. As the air encounters the gradually increasing diameter of the air guide members **56** and begins to turn into the annular space between the housing portions **50** and the air guide members **56**, the air accelerates gradually and thereby reduces pressure loss that can otherwise occur when air rapidly increases in velocity. Thus, the air guide members **56** and housing portions **50** passively gradually accelerate the air in preparation for entry into the area of the fans **36**.

Likewise, air discharged from the fans **36** enters into the annular space at the fan outlets **48** between the housing portions **50** and the air guide members **56**. As the air exits the housing portions **50** and encounters the increasing diameter of the air guide members **56**, the air gradually decelerates. The gradual deceleration induced by the shape of the air guide members **56** streamlines deceleration for regain of pressure and overall lower pressure losses that can otherwise occur with more rapid deceleration.

In further embodiments where the axial lengths of the annular passages are greater than the diametrical distances of the annular passages, the aspect ratio of the annular passages facilitates stabilization of air flow for more efficient operation. That is, the air flow may include turbulent flow, and the aspect ratio serves to straighten the flow and reduce turbulence. The turbulent flow can be due to the change in flow direction over the gradually increasing diameter portions of the air guide members **56** and/or a natural "swirl" within the air received into the air handling device **20**.

In further embodiments that include one or more vanes **64** within one or more of the annular passages, the vanes **64** facilitate stabilization of air flow for more efficient operation. That is, the vanes **64** serve to straighten the flow and reduce turbulence.

FIG. **5** shows another example air handling device **120**. In this disclosure, like reference numerals designate like elements where appropriate, and reference numerals with the addition of one-hundred or multiples thereof designate modified elements. The modified elements are understood to incorporate the same features and benefits of the corresponding elements. In this example, the air handling device **120** is somewhat similar to the air handling device **20** previously described, but includes a bank of fans **136** that includes three fans, as shown in FIG. **6**. In this example, each of the fans **36** is an axial fan, but may alternatively be a centrifugal fan. The fans **36** are arranged in a row and, as previously described, each include a fan inlet **46** and fan outlet **48** with corresponding housing portion **50** and air guide members **56** that operate substantially as described above.

In this example, the air handling device **120** also includes a plenum box **170** arranged above the bank of fans **136**. As shown in FIG. **7**, the plenum box **170** includes one or more grates **172** through which air is received from the bank of fans **136**. The grates **172** are generally arranged toward

opposite lateral sides of the plenum box **170** such that air received through the grates **172** is then forced through filters **174** before discharge of the air into the building or other structure.

Optionally, as shown in FIG. **8**, the air handling device **120** (or **20**) may also include dampers **176** for controlling the flow of air into the fan inlets **46**. Each of the fans **136** may include its own set of dampers **176** or, alternatively, a single set of dampers **176** may be used to control flow of air to all of the fans **136**.

FIG. **9** illustrates a modified plenum box **270** that may be used instead of the plenum box **170** in the air handling device **120**. In this example, the plenum box **270** includes an opening **280** through which air from the fans **136** is received. The air entering into the plenum box **270** is then forced through filters **282** before being discharged into the building or other structure from the plenum box **270**.

Although a combination of features is shown in the illustrated examples, not all of them need to be combined to realize the benefits of various embodiments of this disclosure. In other words, a system designed according to an embodiment of this disclosure will not necessarily include all of the features shown in any one of the Figures or all of the portions schematically shown in the Figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from the essence of this disclosure. The scope of legal protection given to this disclosure can only be determined by studying the following claims.

What is claimed is:

1. An air handling device comprising:

a fan including a fan hub and a set of fan blades that extend from the fan hub, the set of fan blades defining a fan diameter and the fan hub defining a hub diameter, wherein the fan has an inlet side for air intake and an outlet side for air discharge;

an annular fan inlet passage arranged at the inlet side of the fan; and

an annular fan outlet passage arranged at the outlet side of the fan, the fan inlet passage and the fan outlet passage each defining an outer diameter that is substantially equivalent to the fan diameter and an inner diameter that is substantially equivalent to the hub diameter, wherein the annular fan inlet passage and the annular fan outlet passage each extend over a diametrical distance from the outer diameter to the inner diameter and over an axial length, the diametrical distance being constant over the axial length, and wherein the axial length is greater than the diametrical distance.

2. The air handling device as recited in claim **1**, wherein at least one of the annular fan inlet passage and the annular fan outlet passage includes at least one vane extending from the inner diameter to the outer diameter.

3. The air handling device as recited in claim **1**, wherein the fan is an axial flow fan.

4. An air handling device comprising:

a plurality of fans each including a fan hub and a set of fan blades that extend from the fan hub, each set of fan blades defining a fan diameter and each fan hub defining a hub diameter, wherein each fan has an inlet side for air intake and an outlet side for air discharge;

a plurality of housing portions respectively arranged at the inlet sides of the fans, each housing portion defining an internal cylindrical space that has a diameter that is substantially equivalent to the fan diameter of the corresponding fan; and

a plurality of air guide members that each include a cylindrical portion and a portion extending from the cylindrical portion that gradually increases in diameter, the cylindrical portions respectively extending in the internal cylindrical spaces to define annular passages there between, each cylindrical portion defining an outer diameter that is substantially equivalent to the hub diameter of the corresponding fan, wherein each annular passage extends over an axial length and over a diametrical distance, wherein the diametrical distance is from the outer diameter of the cylindrical portion to the diameter of the internal cylindrical space, the diametrical distance being constant over the axial length, and the axial length is greater than the diametrical distance.

5. The air handling device as recited in claim **4**, wherein the plurality of fans are arranged side-by-side.

6. The air handling device as recited in claim **4**, including at least one vane arranged in at least one of the annular passages, the at least one vane extending from the outer diameter of the corresponding cylindrical portion to the diameter defined by the corresponding housing portion.

7. The air handling device as recited in claim **4**, wherein the plurality of fans are axial flow fans.

8. The air handling device as recited in claim **4**, wherein the plurality of fans are generally enclosed within a housing that defines an inlet and an outlet where the plurality of fans are arranged to move air between the inlet and the outlet, and the housing includes therein a perforated surface and a liner material backing the perforated surface.

9. The air handling device as recited in claim **4**, including a plenum box arranged downstream from the plurality of fans, the plenum box including a filter therein and at least one grated-inlet arranged to receive air flow from the fans.

10. The air handling device as recited in claim **4**, including a plurality of dampers arranged in a one-to-one correspondence with the annular passages and operable to control flow of air to into the corresponding one of the plurality of fans.

11. The air handling device as recited in claim **4**, wherein the plurality of fans are generally enclosed within a housing that defines an inlet and an outlet where the plurality of fans are arranged to move air between the inlet and the outlet, and the housing includes an access window adjacent the plurality of fans that is sized to receive at least one of the plurality of fans there through.

12. The air handling device as recited in claim **11**, wherein the plurality of fans are removably mounted in the housing.

13. The air handling device as recited in claim **12**, wherein the plurality of fans each include a base having a sliding surface.

14. The air handling device as recited in claim **13**, wherein the sliding surface comprises a low-friction material.

15. The air handling device as recited in claim **13**, wherein the sliding surface comprises a castor.

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